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Composite Messaging System for Traffic Management in Smart Cities

J. SasiBhanu, K.V.S. Sreeharsha, K. Vyshnavi and J.K.R. Sastry
Department of Electronics and Communication, KL University,
Vddeswaram, 533502 Guntur, District Andhra Pradesh, India

Abstract: An intelligent traffic management system can be conceived through many of individual sub systems which include bio sensing, remote sensing, imaging, cognitive expert systems, messaging, visualization, integrated hybrid communication system. Each of the sub systems while is expected to work independently, should also be in existence in unison along with other sub systems. Messaging systems helpsin showing traffic routes by using electronic signs to send real time information to travelers about events and traffic conditions so that motorist can take instantaneous decisions to travel in the right directions. Information that should be displayed on the message sign include speed limit, traffic flow, congestions, diversions, road closures, alternative routes, hazardous situations, work ahead, in-coming traffic situation, weather condition, the date, time, temperature, availability of public transport etc. The efficiency of the message display is dependent on many factors that are supported by different technologies in use. There has not been a single technology that is capable of all message display requirements. For efficient messaging a composite system that considers all the messaging requirements has to be supported. In this study, a survey on technologies that can be usedfor displaying sign related messages on the sign boards across the traffic route for giving guidance to the drivers for moving their vehicles in the sign directions have been presented and an extent to theses technologies could meet the Traffic monitoring and controlling requirements has been presented. A composite messaging system that is amenable for traffic management within smart cities has been presented.

Key words: Sign boards, traffic management, smart cities, messaging systems, composite systems

INTRODUCTION

Messaging is a system that helps to send information directly to message signs. Variable Message Sign (VMS) is an electronictraffic sign placed onroadwaysto give travelers information about special events. The information like speed limit, road closures, congestions, diversions, alternative routes, work aheadetc. Must be displayed in real time through VMS boards

A messaging system can be portrayed as a cascaded system which receives inputs from various sensing and transmitting systems and the system displays output messages on the messaging boards. A typical layout of a messaging system is shown in Fig. 1. The standard messaging system commences with the data leaving the control station. Then it reaches the substation through various communication interface protocols such as National Transportation Communications for Intelligent Transportation System Protocol (NTCIP). From substations, the local loops collect the data and in turn provide it to the sensors and actuators. The actuators are responsible for displaying the real time messages or message signs based on the data processed by the local control units. Population development, user development and growing vehicle ownership in urban centers cause increasing demand of traveling as well as the volume of vehicles through the city's streets. Today traveling period problem is one of the most important problems of metropolitans in street network due to the elevating density of urban. A significant portion of time traveling in the transport network in large cities is related to the problem of traffic. Hence, traffic control today is among the essential issues that involve people with expertise and experience. The engineering of traffic consequently, requires collection and analysis of traffic information just like number of cars, speed, traffic flows. Traffic surveillance systems have played a significant role in movement of traffic from one location to the other. Efficient Traffic management requires automatic analysis, intelligent and optimal control of the traffic

Messaging refers to the display of real time information on the message boards placed on the road. Today with wide development of technology such as LED screens, optical fibers, flip disks etc., displaying the message signs has become practical. Based on the data obtained from the traffic monitoring systems, messages

Corresponding Author: J SasiBhanu, Department of Electronics and Communication, KL University, Vddeswaram, 533502 Guntur, District, Andhra Pradesh, India

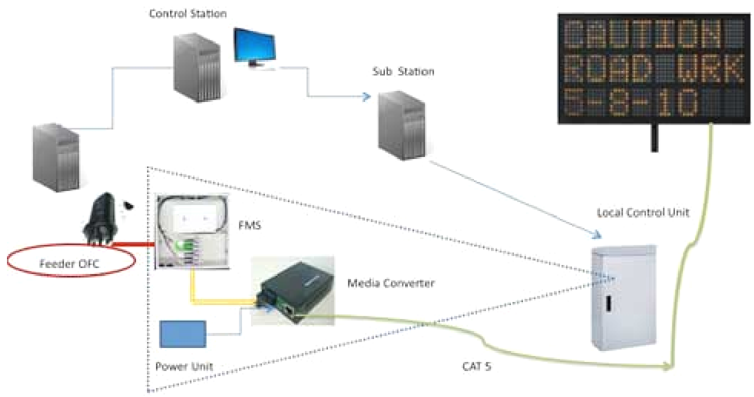

Fig. 1: Basic messaging system

have to be generated which are appropriate to the current situation and the same are displayed based on the time calculated using fuzzy logic.

In traffic management, messaging can be achieved by VMS Systems. Variable Message Signs (VMS) provideroute travel information for motorists. VMS boardsare normally introduced on full-traverse overhead sign extensions, post-mounted on roadway shoulders and overhead cantilever structures. The message display systems can be controlled form a local or a remote system based on the data received about the traffic from different traffic positions. VMS are intended to enhance movement stream and operations. The data showed on VMS might be an aftereffect of an arranged or spontaneous occasion which is modified by operations work force.

The traveler information includes travel time between known destinations, blockage conditions along a freeway corridor, construction notices, special event notification and instructions for motorists, maintenance operations plan, pending sever weather declaration, occurrence warning. The goal of giving data is to permit the driver time to keep away from an occurrence, plan for unavoidable conditions or to give travel bearings. For all data showed, the objective is to positively affect the driver's travel time.

The display of messages on the sign boards involves many complexities that must be handled. Some of the complexities that are to be handled include the following:

- The positioning of the VMS boards should be done in a way such that the messages can be visible to travelers properly
- The messages should convey the exact information regarding the current situation of the traffic ahead. They should be simple such that travelers can understand them easily
- VMS boards should be able to display the information even in the presence of humidity, high temperature, rainfall etc
- The VMS boards may fail due to lack of power supply, controller failure, display failure, sensor failure, backlighting failure etc
- Messages may not be displayed properly due to loss of network communications

VMS systems must be of high quality to ensure that the display stems works in accurate manner as in misguidance to the motorists will be catastrophic: The following are some of the requirements that must holded by the VMS systems:

- VMS signs must be ruggedized
- Non-working of VMS must be identified and alternate systems must be provided to display the routing
- VMS systems must implement chaining mechanism.
- VMS systems must be color coded
- The signals to the VMS system must be able to ignite a VMS system located at least 1 km away from the signal post
- Must be able to display the route status using matrix boards
- Must be able to control luminosity of VMS based on weather conditions and the time at which the display systems are initiated
- VMS systems should be able to display the speed at which the vehicle should move in gradual degraded manner
- The signal post system must be able to receive the input from VMS devices connected to onto moving vehicles.

The existing system of message signs or sign boards cannot give satisfactory results in the days to come. The smart cities of the future need much more sophisticated and precise systems to meet its requirements in terms of population, complex traffic issues. The existing system of displaying sign boards is not dynamic and in the times of unexpected road blockages completely fails as it cannot convey the information regarding the problem ahead. So, far various types of variable message signs are used that display different signs according to the need. But they failed because of their inability to get integrated with a system. Though many improvised versions of VMS (like flip disks, LED matrices etc.,) were developed, many of them still lacked in some desired qualities. To make better use of the VMS, we propose a system integrating it with a cognitive system that manages to give inputs to the VMS so that the traffic congestions will be minimized.

Literature review: Hannes Kulovits Swarcoet presented a prototype for messaging for smart automation of traffic signal system to display real time messages using VMS boards. It is implemented by detecting the emergency vehicles and density of the traffic simultaneously there by display the messages based on the priority outcome. Density of the traffic is detected by installing IR detectors along the side of the lane. Main aim is to control traffic congestion with the help of VMS boards. At junction points, the traffic monitoring systems collect the data from sub stations. The sub stations are interconnected to one or more Local Control Unit (LCU) that in turn is wired to sensors and actuators. Local Control Units are responsible for processing data and autonomous control jobs. The sensors present in an LCU convert the protocols into instructions such that the microcontroller present in the VMS can display the required message on the screen.VMS are divided into sign units which are limited.Each sign unit can be controlled by specific sign control and appropriate protocol.The LCUs gathers the information from the sensors associated with the VMS and in turn provide required operational information for VMS. TheVMS itself takes the autonomous actions depending on the gathered data.

Arash, have represented an algorithm pertaining to generate suitable messages based on the information gathered from the monitoring system. This approach can be used to generate messages and display them for a time which is calculated by using fuzzy algorithm. Fuzzy logics are used to process the data at junction points. They serve as a means of representing and manipulating data that are rather fuzzy. Fuzzy logic helps in modelling the ambiguity and the uncertainty in decision making. Besides, fuzzy logic produces control methodologies and comprehends the linguistic instructions based on the priori communications. It is a control model based on the human expert knowledge. Fuzzy logic tries to imitate human deduction by using computer algorithms.

David Levinson presented a study on the effectiveness of variable message signs.The viability of Variable Messages Signs (VMS) is evaluated by a discrete probity decision display that gauges the extent of vehicles that occupies to an option courses given the attributes of various messages. Studies conducted directed to quantitatively assess the system wide diminishment of travel time and aggregate postponement of VMS frameworks. We find that VMS has no undeniable impact on decrease of travel time, however can diminish the aggregate postponement.

Upchurch *et al*. (1992) presented a study in whichthree unique innovations for variable message signs were assessed as far as target worth, intelligibility separation and review comfort. The innovations assessed were flip plate, Light-Discharging Diode (LED) and fiber optic. For examination purposes, routine overhead guide signs were likewise assessed. Twelve signs were assessed in the field in a human components study; procured eyewitnesses measured target worth and readability separation from a moving vehicle on the road and subjectively assessed seeing solace. Perceptions were made fewer than four lighting conditions: late morning, night, washout and backdrop illumination. For target esteem, intelligibility separation and review solace, fiber-optic signs performed superior to LED signs in many conditions. It has been reported that fiber-optic and LED signs have proved to be adequate for the expressway administration framework.

Hui *et al*. (2013) presented a study which studies thedriver's understanding of different five signs by means of surveys.Variable message signs can show content data, as well as realistic data. Realistic data can be distinguished further in distance than content data. Additionally, the graphical data is not restricted by dialect, as various nations can utilize the same graphical signs. The outcomes demonstrated that driver's determination of graphical signs had huge contrasts.

Cohn *et al*. (2004) presented a system in which VMS signs are modified to improve their performance. Variable Message Signs (VMS) have been utilized for various years in a wide range of nations. VMS-frameworks take numerous structures and their viability relies upon their setup, nearby qualities and driver conduct. Late advancements in micro-simulation have made it conceivable to reproduce precise determining of the viability of VMS is dependent on precise programming to assess the drivers reaction. We have built up another device for recreating VMS-frameworks in parametric reproduction models. The task process permits the client to straightforwardly impact the decisions of drivers at particular areas amid a recreation. This is of specific useful use for displaying. They have presented a new VMS device that takes into account the drivers reaction. The device permits the modeler to discover that all drivers have a particular sort off course data at a particular area and to decide the reaction of the drivers in the recreation. Rama and Kulmala (2002) studied on the effect of VMS signs on the driver behavior. This field study examined the impacts of two Variable Message Signs (VMS) on driver conduct. In particular, the signs were a notice sign for elusive street conditions and a base progress sign. The study was executed as a prior and then afterward tries at three test destinations in Finland with an after period covering two winter seasons. The outcomes demonstrated that the elusive street condition sign diminished the mean pace on dangerous streets.

Boyle and Mannering (2004) presented a study which investigates the impacts of driving conduct utilizing as a part of vehicle and out-of-vehicle movement counseling data identifying with unfriendly climate and occurrence conditions. A full-estimate, settled based driving test system is utilized to gather information on driver's pace conduct under four distinctive counseling data conditions: in-vehicle messages, out-of-vehicle messages, both sorts of messages and no messages. The discoveries of this study recommend an intriguing marvel in that while messages are noteworthy in diminishing rates in the territory of unfavorable conditions. Drivers have a tendency to adjust for this rate lessening by expanding speeds downstream when such antagonistic conditions don't exist.

Kulovits *et al*. (2005) presented a study which says that an increasing prominent strategy for overseeing interstate movement is to utilize Variable Message Signs (VMS). A neural system model is exhibited for ongoing control of a VMS framework in turnpike work zones. The neural system is prepared to recognize the begin of a line in a work zone and give a message in the turnpike upstream. The voyagers are educated about the blockage in a work zone when a line begins to shape. The canny VMS framework can be prepared with information for various periods inside a day. Two distinctive neural system preparing principles are utilized: the straightforward Backpro Pagation (BP) and the LevenbergMarquardt BP calculations. The system is prepared utilizing information adjusted from the deliberate information. In light of various numerical analyses it is watched that the union pace of the Levenberg Marquardt BP calculation is no less than one request of greatness quicker than the basic BP calculation for the work zone activity line location issue.

Roshandeh *et al*. (2009) presented a study to evaluate the viability of Variable Message Signs (VMS) data amid driving. The outcomes demonstrate that huge contrasts in driving conditions happen if the driver does not comprehend the sign. The related VMS drawing nearer speed diminishes <5% if the sign is not caught on. In actuality when the driver comprehends the message the velocity profile is verging on stable. Also the weight on the quickening agent pedal abatements drawing closer the sign and increments after it when the driver has comprehended the message, generally the weight on the pedal continues diminishing.

MATERIALS AND METHODS

Finding suitable systems for displaying message signs fortraffic management: A variable messaging systems should be having many components in it which include Text display systems, beacons, display modules, display drivers, power supply systems, Various types of sensors especially the temperature and light sensing devices, fans, filters, control cabinet, field control units, I/O boards, modems and Computer units which are either located locally or at remote locations.

The sign structures are the ext display systems that are ordinarily built of aluminium with clear, hostile to glare, Lexan facings. Some more up-to-date systems have been built using LEDs or lenses. The structures are intended to be strong against temperature and other climate components. The majority of the major VMS parts are contained inside the showcase structure.

Beacons are flashers or guides are gadgets that are utilized to attract more thoughtfulness regarding a sign when a critical message is being shown. They can be found inside the sign face, mounted to the highest point of the sign structure or on close-by posts.

Display modules are contained within the sign structure and make up the display matrix. Every module comprises of various pixels. The pixels are arranged in segments and columns. At the point when initiated together, pixels structure characters, numbers and letters. With a gathering of various modules, messages can be shown.

Display drivers are hardware that controls the information yield to the showcase modules. There is regularly one driver for each module however, some signs contain line and section drivers or even one driver that controls numerous modules. Drivers are situated on or close to the showcase module they control. More up to date presentations are incorporating the drivers onto the showcase module hardware. The showcase drivers are addressable and set per the module's area in the presentation grid. This guarantees the craved character will be shown on the right module.

Power supplies contain numerous DC power supplies that stimulate modules and different parts. The power supplies are adjustable in nature that keeps adjusting as per power requirement. The sign contains various sensors that permit the field controller to adjust to ecological changes. Temperature sensors take interior and outer temperature readings. The field controller responds as needs be, to either warmth or cool the VMS. Light sensors record outside encompassing light levels. The field controller changes the showcase power level to make up for day and night conditions. The fans, actuated by the field controller, keep up appropriate working temperatures and wind stream inside the showcase environment. Filters are utilized to keep up a without dust show framework environment. Most shows contain admission and fumes channels. Channel areas change in the middle of makers and sign models. The cabinets are for the most part situated close to the sign structure. Contingent upon the maker, the bureau can house AC load focuses, modems, fibre parts, correspondence punch-down squares and field controllers.

Field controller is the focal processor for the VMS. The field controller contains memory for message and schedule storage. It controls the showcase yields and all peripherals inside the sign. Correspondence with the controller can be locally or remotely by means of a PC. The input/output circuit board screens all the sensor yields. It likewise controls reference points and other hand-off controlled gadgets. The I/O board's yield permits the field controller to react to sensor changes as required.Modems are the gadgets that permit the administrator to convey to the field controller from a remote area. Remote Communication can be through copper or fibre runs.

A local control system comprises of a portable PC with control programming. This is utilized to help a field expert with investigating, diagnostics and repair. The tablet associates specifically to the field controller utilizing RS-232 serial interface. Late field controllers have a client interface, comprising of a presentation screen and info controls. This diminishes the requirement for portable PC and maker programming.

A remote control framework comprises of a bigger PC setup associated by means of a system. This permits administrators and specialists to analyse and control the VMS shows from a remote place. The Northwest Region's Regional Traffic Management Centre at Dayton contains the remote framework for our regions. Dayton uses a DOT built NTCIP programming to control the locale's VMSs. This product involves message control, yet needs implies for any diagnostics. Various messages display technologies are being used as today which include variable message signs, Flip disks, Fiber optics, hybrid and alike. A variable message sign is an electronic movement sign regularly utilized on roadways to give explorers data about unique occasions. Such signs caution of movement clog, mischances, occurrences, roadwork zones or speed limits on a particular parkway fragment. In urban ranges, VMS are utilized inside stopping direction and data frameworks to guide drivers to accessible auto parking spots. They may likewise request that vehicles take elective courses, limit travel speed, caution of span and area of the episodes or simply illuminate of the activity conditions.

Early variable message signs included static signs with words that would enlighten showing the sort of occurrence that happened or signs that utilized turning crystals (trilions) to change the message being shown. These were later replaced by dot matrix displays normally utilizing eggcrate, fiber optic or flip-circle innovation which were fit for showing a much more extensive scope of messages than prior static variable message signs. Since the late 1990s, the most widely recognized innovation utilized as a part of new establishments for variable message signs are LED shows. As of late, some more current LED variable message signs can show shaded content and representation.

Flip Disk is an innovationthat uses an arrangement of little round, square or rectangular plates which exclusively pivot or flip to frame characters on the VMS. Every circle has intelligent material on one side that, when "flipped" is presented to frame the message. LED technology uses bunches of strong state diodes that shape a single pixel. At the point when voltage is connected, every diode sparkles. By killing voltage on or, every pixel bunch is controlled into shaping the characters or example of the showed message.

Fiber optic VMS technology uses groups of fiber optic strands hung between every pixel and a light source. A single light source resolves a few pixels. To control which pixels are shown, shades are put before every pixel. At the point when a message is shown the attractively controlled screens open or stay near structure a character or example. A typical hybrid VMS uses both flip plate and either fiber optic or LED innovation. Every flip plate has an opening in its inside for light to go through. The light is created by a fiber optic package or LED bunch. At the point when the pixel is enacted the circle is flipped, permitting light to go through the opening while showing the intelligent side of the plate to activity. At the point when the pixel is off its intelligent surface is turned or flipped, obstructing the light source.

Messages showed on a VMS are finished by utilizing single or numerous stages. A stage is characterized as the points of confinement of the showcase range accessible for content, bitmaps or activity. Messages that require more data than can be appeared on a single VMS show space may require the utilization of different stages. Various stages permit more than one message to be shown at an area. Overhead variable message signs are today accessible in three structure elements: front access, back access and stroll in. In a front access variable message sign, upkeep is performed by lifting the sign open from the front. Littler VMS are of the front access structure considering and are ordinarily introduced today on major arterials. The back access structure element is like the front access structure element with the exception of that upkeep is performed from the back of the sign and is generally utilized for medium-sized element message signs introduced along the roadside of expressways (rather than overhead). The stroll in structure component is a later presentation where support on the sign is performed from within the sign. A key point of interest of the stroll in structure element is that path terminations are by and large not required to perform support on the sign. A large portion of the biggest VMS units introduced today are stroll in units and are normally introduced overhead on roads.

Early models required an administrator to be physically present when programming a message while more current models might be reconstructed remotely by means of a wired or remote system or cellphone connection. A complete message on a board by and large incorporates an issue explanation showing occurrence, roadwork, slowed down vehicle and so on.; an area proclamation demonstrating where the episode is found; an impact articulation demonstrating path conclusion, delay and so on and an activity articulation giving proposal what to do movement conditions ahead. These signs are additionally utilized for AMBER Alert and Silver Alert messages. In some spots, VMS's are set up with perpetual, semi-static presentations showing anticipated travel times to critical movement destinations, for example, real urban communities or exchanges along the course of a roadway.

A comparison of the variable message systems based on the technology used is shown in Table 1. Comparing different existing technologies gives us sufficient knowledge to get an idea about the existing systems and their advantages as well their shortcomings. Table 1 shows comparison of 4 technologies flip disk, LED, fiber optics and Hybrid VMS which are being used extensively as on date

When it comes to the implementation of VMS for an application, one must check the suitability of a VMS in comparison to an application requirement. Table 2 shows

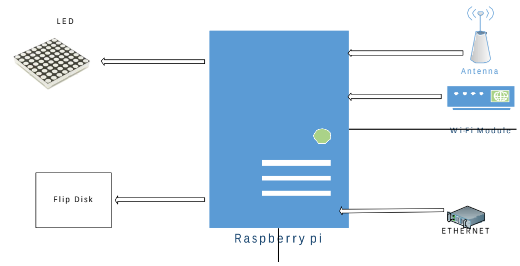

Fig. 2: Block diagram of composite system using LEDs and flip discs

the comparison of the technologies with respect to the functional requirements of traffic management system. It is seen from the comparisons placed in Table 2 that no single implementation meets all the requirements of a traffic management system, making it necessary to integrate two or three of these technologies. Thus, a new composite system can be formed by combining some implementations through an intelligent interface so that all the requirements of the system are achieved.

The composite system for effecting variable message signs: To meet the functional requirements of the traffic management system, at least two of the devices (Flip Disc, LED) or (LED, HYBRID) have to be used and should be integrated into an embedded board that has the interfaces using which, communication can be made with signal post systems, Local base stations and remote monitoring and controlling station which are the three main computing nodes within a traffic management systems. Two of the approaches can be used for implementing integrated VMS systems that best suits the traffic management system.

Composite system 1 using LED and flip disk: To meet the functional requirements of a traffic management system an integrated system can be built using LEDs and Flip Disk integrated into Raspberry pi board. LED's are very easy to maintain and the flip disks assure low power consumption with sharp and legible display quality. These two technologies are integrated into a raspberry board to provide a composite VMS system. Depending on the inputs of the board it drives LED's and flipdisks for better efficiency. The block diagram which shows the functioning of the composite system is shown in Fig. 2.

Composite system 2 using LED and hybrid VMS: The second system can be designed by choosing LED and hybrid VMS. LED's are easy to maintain and are portable.

Table 1: Comparison of VMS technologies

Tech	Advantages	Disadvantages
Flip disk	Proven technology	More moving parts leads to additional maintenance
	Low power requirements	Reflective disk surfaces can become sun-bleached over time
	Provides a sharp legible message	Not very visible during low level light conditions
LED	Visibility is good under most lighting conditions	Smaller cone of vision reduces message legibility at close distances
	Fewer moving parts require lower maintenance	Diodes can be sensitive to heat
	LED's are rated for 100,000 h of service	
Fiber optic	Good visibility under normal operating conditions	More moving parts leads to additional maintenance
	Provides a sharp legible message	Lamps are typically rated for only 8,000-10,000 h of service
		Cannot adjust illumination intensity for various light conditions
Hybrid	Can still utilize sign if light source fails	More moving parts leads to additional maintenance
	Provides a sharp legible message	Reflective disk surfaces can become sun-bleached over time

Table 2: Comparing VMS technologies with respect to the requirements of a traffic management system

Functional requirements of traffic management system	Flip disk	LED	Fiber optic	Hybrid
Ruggedized	✓	X	✓	✓
Identification of non-working VMS and replacing them with alternate systems	✓	✓	X	✓
Chaining mechanism	X	✓	✓	X
Ability to communicate with distant signal posts	✓	✓	✓	✓
Ability to control the parameters based on climatic conditions	X	✓	X	✓
Portability	✓	✓	✓	✓
Low maintenance		✓		
Color coding	✓	✓	✓	✓

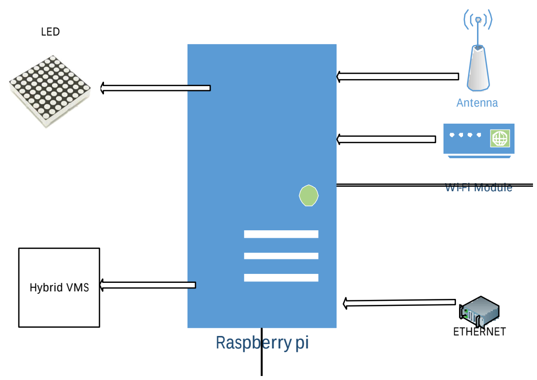

Fig. 3: Block diagram of composite system 2 using LEDs and Hybrid VMS

Hybrid VMS are adaptable to the weather conditions and can adjust their luminosity according to the requirement. This makes it an important component of the system. These two are integrated into a raspberry pi board to form into a composite system. Figure 3 shows the 2nd option of the composite system that can be achieved through LED and VMS integrated intoraspberry pi board.

It is clear from figures the LED, VMS and Flip disks are used to sense different parameters. These sensed values are sent to the Raspberry pi board which processes these signals and digitizes them further using different conversions. Then the converted signals are further sent to the control stations using on-board Wi-Fi and Bluetooth technology

An antenna interfaced to the raspberry Board acts as a transmitter as well as receiver in communication systems. Antenna basically uses microwaves for information transfer. It is nothing but a conductor terminated at the end. Microwaves when passed through it enter the atmosphere and make the communication possible. Raspberry pi uses a module that receives the microwaves and processes them. Making use of this module we can integrate microwave communication for information transfer between the signal posts. The Ethernet port provided on the raspberry board can be used for communication using an existing LAN. TCP/IP communication protocols can be used for communication through Ethernet cables. These cables can be connected to the raspberry pi board by the Ethernet module built in it. This Ethernet module makes it more versatile and makes the communication much easy.

Wi-Fi is the protocol which can be used for communication with either local signal postsystem through which it enables the devices to get connected wireless. In other words Wi-Fi is nothing but wireless Ethernet. It uses bandwidth from 2.4-5 GHz. As the Raspberry pi board can handle these Wi-Fi signals, it makes the communication between signals posts very simple. A comparison of the composite system with other systems is shown in Table 3.The composite systems proposed presented in this study meets all the functional requirements of traffic management system while other technologies could meet only few of the features required.

Table 3: Comparison of composite system with other VMS technologies

Functional requirements	Flip disk	LED	Hybrid	Composite system 1	Comment
Ruggedize	✓	✓	✓	✓	Same for both the systems
Identification of non-working VMS and replacing them with alternate systems	✓	✓	✓	✓	Easy in system 1 as the flip provide disks better alternatives hybrid VMS than
Chaining mechanism	✓	✓	✓	✓	More efficient in system 1
Ability to communicate with distant signal posts	✓	✓	✓	✓	Efficient in system 2 as hybrid VMS has wider range
Ability to control the parameters based on climatic conditions	✓	✓	✓		Efficient in system 2
Portability	✓	✓	✓	✓	
Low maintenance	✓	✓	✓	✓	System 1 is easy to maintain as it consumes less power
Color coding	✓		✓	✓	Can be done easily in both the systems

CONCLUSION

In this term study, various technologies for implementing variable message signs are investigated using which the sign related messages are composed and the same are transmitted to the sign boards across the traffic routes which gives guidance to the drivers for moving their vehicles in the sign directions. This solves the problem of undesired traffic congestions due to the conventional system of displaying painted signs. This report emphasizes on the comprehensive study of existing VMS technologies. By avoiding the shortcomings of each system and utilizing their advantages completely new composite systems are developed for VMS which significantly improves the efficiency of traffic management. This VMS system when implemented along with the cognitive system is more reliable in the view of the upcoming smart cities.

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