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Emergency Service Responder With Traffic Controlling Agent in Context-Aware Healthcare Application

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Abstract

Many context aware applications have been proposed with the advancement in technology. People are being benefited from context aware applications in tourism and transportation system. In this paper we propose a context aware application in health care system that guides the ambulance to patient location and then back to hospital, we consider present traffic and efficiently handle traffic signals when ambulance move close to signals - this allow ambulance to bypass traffic signal without getting stuck in traffic, in case of two or more ambulances happen to cross same traffic signal we gave priority to most critical patient, it also considers patient's medical record while selecting hospital and hence minimizing time required to get the treatment. Simulation results shows that proposed system saves time in getting treatment for patients.

Keywords: Component; Emergency Service Responder, Context data, Emergency Traffic Controller.

Introduction

Context – awareness refers to knowledge and understanding of the surrounding environment within which the decision support system has to operate. For instance, available bandwidth, device profile, and last completed transaction are all context attributes [1]. The role of context for better decision-making has been a significant research effort over the years [2]. In the field of computer science context is defined as "the set of environment states and settings that either determines an application's behavior or in which an application event occurs and is interesting the user" [3].

In case of medical emergency, the patient has to be moved to the hospital which has the facility to treat the patient based on his medical condition, without knowing the medical records the patient might end-up in hospital which has no facilities to treat in that particular case, in that case the patient has to be moved to different hospital which result in delayed treatment and will lead to bitter consequences.

Most of the specialized hospitals are located in metropolitan cities hence patient has to be transported through the heavy traffic, we have seen ambulance being struck in slow moving traffic or in traffic jam, there is no way we can clear the road for ambulance without being clearing the distant traffic along the path. This will again result in delayed treatment during medical emergency.

Taking the advantages of mobile computing and context awareness, we are proposing a new approach to handle these scenarios. In this paper we are proposing an organized integrated system which efficiently routes patient to the desired hospital based on the availability of hospital resources which in turn depends on patient medical record.

Organization Of Paper

In Section 2 of the paper we present the Related Work, Section 3 gives the proposed architecture, and in Section 4 evaluation is presented and Section 5 draws conclusion.

Related Work

Anind K D [4] defines context as any information that can be used to characterize the situation of an entity that is relevant to the interaction between a user and an application, including the user and the application themselves**.**

Chen [3] defines two kinds of context namely active context that influences the behaviors of an application, and passive context that is relevant but not critical to an application. They also propose two ways to use context automatically adapt the behaviors according to discovered context. Accordingly they define context-aware computing - active context awareness application automatically adapts to discovered context by changing the application's behavior, passive context awareness application presents the new or updated context to an interested user or makes the context persistent for the user to retrieve later.

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Instead of inferring activities, the approach proposed in [5] enables the user to explicitly model their activity, and then use sensor-based events to create, manage, and use these computational activities adjusted to a specific context.

With the introduction of web services for healthcare application protection of sensitive healthcare data is of great importance, RBAC (Role-based access control) is presented in [6] where the main RBAC components (users, roles, permissions, sessions) are systematically addressed. Using -this model, efficiency is gained by associating permissions with roles rather than users.

In [7] dynamic, context-aware security infrastructure that can fulfill the security requirements of healthcare applications is proposed which extends the traditional RBAC model to gain many advantages from its context-aware capability.

Intra-hospital communication is proposed in [8] where a system of digital video and audio streams coupled to an event-based programming mechanism for control and notification, here the hospital is wired with sensors to enable tracking the location of staff, patients and equipments, terminals will deployed throughout the hospital providing access to audio/video conferencing and other information system.

Though many ideas were proposed to use context-aware computing, a very small portion of proposed solution has been into real-world usage of context-aware technologies, [9] describes the design and deployment of a context-aware PDA application made to support ecologists in field studies in Africa. In the prototype, context awareness enables the mobile device to provide assistance based on knowledge of its environment in terms of time and position. This paper gives few details on the lessons learned from the deployment, here the context information is used only passively. The active campus explorer application which has been deployed at UC San Diego campus supports context-aware activities, such as instant messaging and location-aware maps annotated with dynamic hyperlinked information.

Demonstration on how agent technology can be used to provide decision support in a dynamic, context sensitive environment is put forward in [10], more specifically they demonstrated the use of mobile agent to support the deployment of an ambulance support services in real-time.

Scenario and Proposed System

Consider a present working scenario. When the person is in need of immediate medical attention, the onlookers immediately call ambulance service providing location of person. The ambulance now has to reach the patient and again should move the patient to appropriate hospital which can treat the patient. The travel time of ambulance to pick-up patient and reach the hospital is greatly affected by the traffic along the path, even though the vehicles make way for ambulance; on numerous occasions the ambulance might caught up in traffic at the end of signal, since the traffic signal was green for other path the vehicles in front of ambulance can't make way for it – which requires traffic police intervention to manually change the signal to clear the path for ambulance, we can't rely on human intervention all the time because he might not be available all the time at all the necessary places (signals). Also without knowing the medical background if you admit patient to some hospital, he might need relocation to get his treatment which will again consume invaluable time

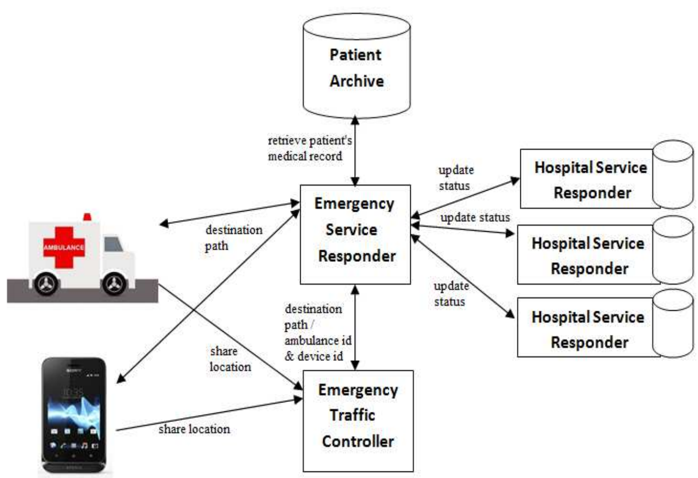

Fig. 1 Architecture of Integrated Emergency Service Responder

In this paper we propose an application comprising web services, mobile computing and context aware data. Fig 1 shows the architecture which involves a integrated system of Emergency Service Responder (ESR), Hospital Service Responder (HSR), Emergency Traffic Controller (ETC) and Ambulance node having on-board device mounted.

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In this proposed system, ESR is a web application which has access to patient medical archive on demand (here we assume that each patient medical detail is updated into this globally accessible database), it also had the real time location of ambulances that are available.

HSR is a real-time web service provider of hospital status, which includes the status of such as availability of doctor and status of medical equipments & their availability. ETC is a module that can be integrated into the present central traffic controller system for any given city. It should accept request from ESR and work with ambulance node to help it reach destination, the entire operation of this system is explained with the sequence diagrams.

With the proposed system in action when an onlooker calls ambulance service giving the identification of patient and location, request now dispatched to ESR. This module will further work independently without any human intervention. ESR having the current location of available ambulance finds the closest ambulance and sends the route to ambulance to reach patient. ESR also sends this route to ETC and ID of ambulance node so that ETC can receive GPS co-ordinates to monitor traffic signal, on the fly the ambulance will signal its location to ETC – Central traffic controller responds by clearing the traffic when the ambulance move towards traffic signal. Figure 2 illustrate the process of ambulance being guided to the patient location and same as been illustrated with the algorithm.

Algorithm: Guiding nearest ambulance to reach patient

A (lat, long): Ambulance location identified by its latitude longitude
P (lat, long): Patient location identified by his/her latitude and longitude
R : Route information from current ambulance location to patient location
AID : Ambulance ID

Begin
A(lat,long)
share location of ambulances with ESR
if (service is requested) **then**
receive location of patient P
  if (A nearest to p) **then**
  inform A to reach patient
  send AID and R to ETC
  send R to A
    if (A(lat, long) != P(lat, long))
    share location of ambulance with ETC
    ETC controls traffic signals along the R
    break
return
end

While ambulance is on its way to pick-up patient, ESR retrieves patient record from archive and knowing the medical condition ESR will now contact hospitals in proximity that can treat patient, HSR is responsible for updating status of doctor and medical equipment. Upon receiving the status update ESR now creates list of hospitals that can treat patient with closest hospital in top priority.

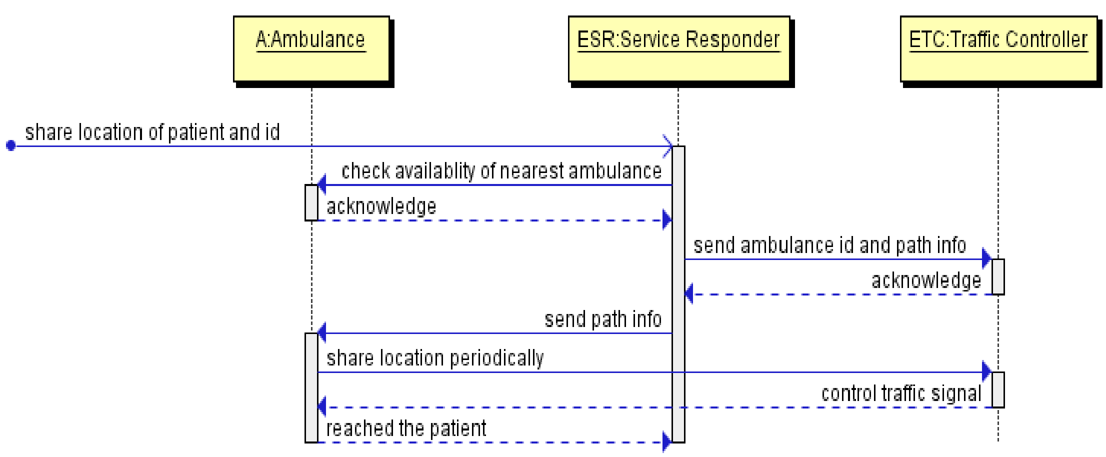

Fig. 2 Obtaining status of Ambulance and Reaching Patient

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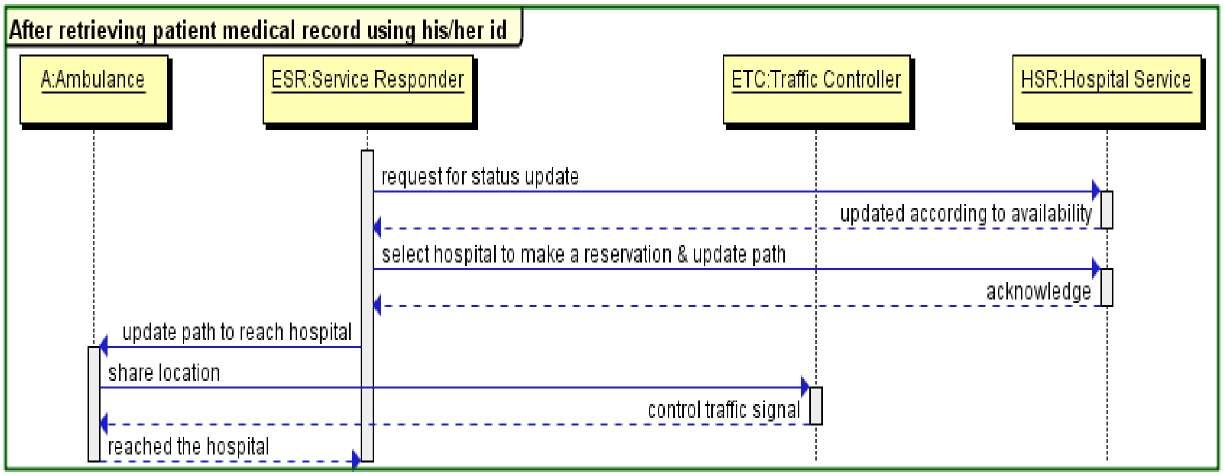

Fig. 3 Obtaining Hospital Status, Prioritize and Reaching Hospital

When ambulance reach patient it informs ESR from its onboard device, ESR now responds with route to closest hospital that can treat patient without fail, the same route is sent to ETC to guide the ambulance to hospital which will work in same manner as it did in signaling traffic with the movement of ambulance. The hospital selected will receive the patient details from ESR and staff will now wait for patient arrival with all necessary precautions. Figure 3 illustrate the process of ambulance being guided to hospital considering the context data and same has been illustrated with the algorithm.

Algorithm: Retrieving context data and ambulance guidance to reach hospital

A (lat, long): Ambulance location identified by its latitude longitude
H (lat, long): Hospital location identified by its latitude longitude
{H} : Hospital list
R : Route information from current ambulance location to hospital location

Begin
Retrieve patient's medical record from patient archive based on some id received
If (H has facility to diagnose patient) **then**
  check for availability of doctor and medical equipment
  if (doctor and medical equipment available) **then**
    request for reservation
    add hospital to priority list
    for every hospital in priority list
      arrange hospital with shortest distance first
    send R to ETC and ambulance
  if (A(lat, long) != H(lat, long)) **then**
    share location of ambulance with ETC
    control traffic signals along the R
  break
end

The patient might not be travelling in ambulance in all cases and in this scenario the traffic will further slow down his movement, here we propose a Smartphone app which is registered with the ESR so that it receives route which can be mapped using available map service and sends its location to configured ETC, this will allow fast movement of patient irrespective of whether patient is being moving in ambulance or other vehicle.

Simulation and Results

A Simulation Procedure

Due to the sensitivity of medical data involved and the lack of technological advancement in the traffic controlling service it is not possible to run our experiment in an actual emergency condition. Instead a simulated model was developed to best understand the working model.

B. Results and Discussion

Consider a scenario where a man had an accident resulting bleeding from his head – a call to ambulance service (which is now equipped with ESR) receive patient id and location. ESR now has the location of say 8 ambulances around the city, it now finds the nearest ambulance and informs it accordingly with route to reach patient. The ambulance shares its location with ETC (which has obtained the route information and ambulance id), ETC now responds by controlling traffic signals along the route. Figure 4 shows

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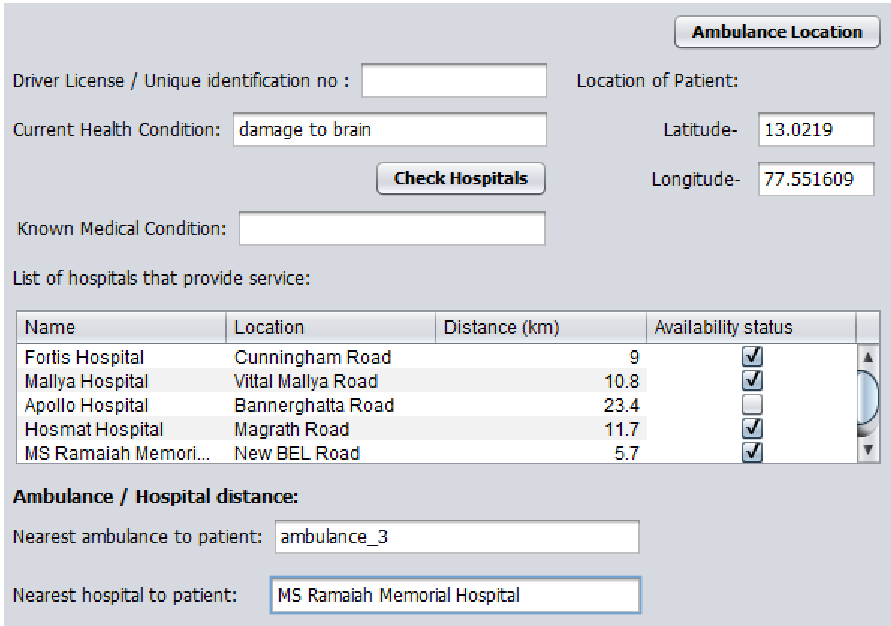

Fig. 4 Emergency Service Responder module

the ESR module which now suggests the nearest hospital which can treat the patient, fig 5 shows how ETC tracks the ambulance node and controls the traffic accordingly.

Fig.6 gives the plot of delay experienced by ambulance service. Taking into account of average delay of 100seconds at each traffic signal, the present system will force the ambulance to pass through these signals unless there is human intervention resulting in extended time to get medical assistance. We also allow 5 seconds worst time response of proposing system to act. This plot clearly indicated that delay in getting treatment increases with increase in number of traffic signals.

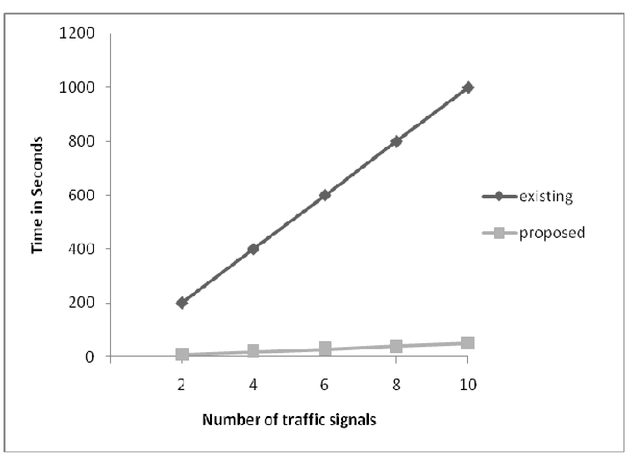

Fig. 6 Delay caused due to traffic signals

Apart from traffic signal delay we need to account for the show moving traffic occurring during peak hours in the morning and evening i.e. when people move to their work place and return home back. Considering this delay altogether we can further minimize the travel time while exact figure of time saved depends on specific occasion which is again dynamic.

Fig 7, provides time response for our proposed system to handle various number of requests. Time taken to handle various number of requests increases as number of request increases, in order to account for this delay we considered multithreading and the resulting delay is the time taken by Emergency Service Responder to learn about current context involving patient location, ambulance location, patient health condition and to respond with nearest ambulance to patient, nearest hospital to patient with the route information.

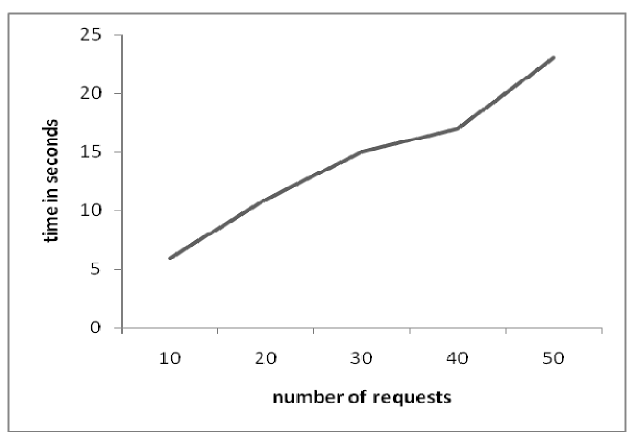

Fig. 7 Response time to number of requests

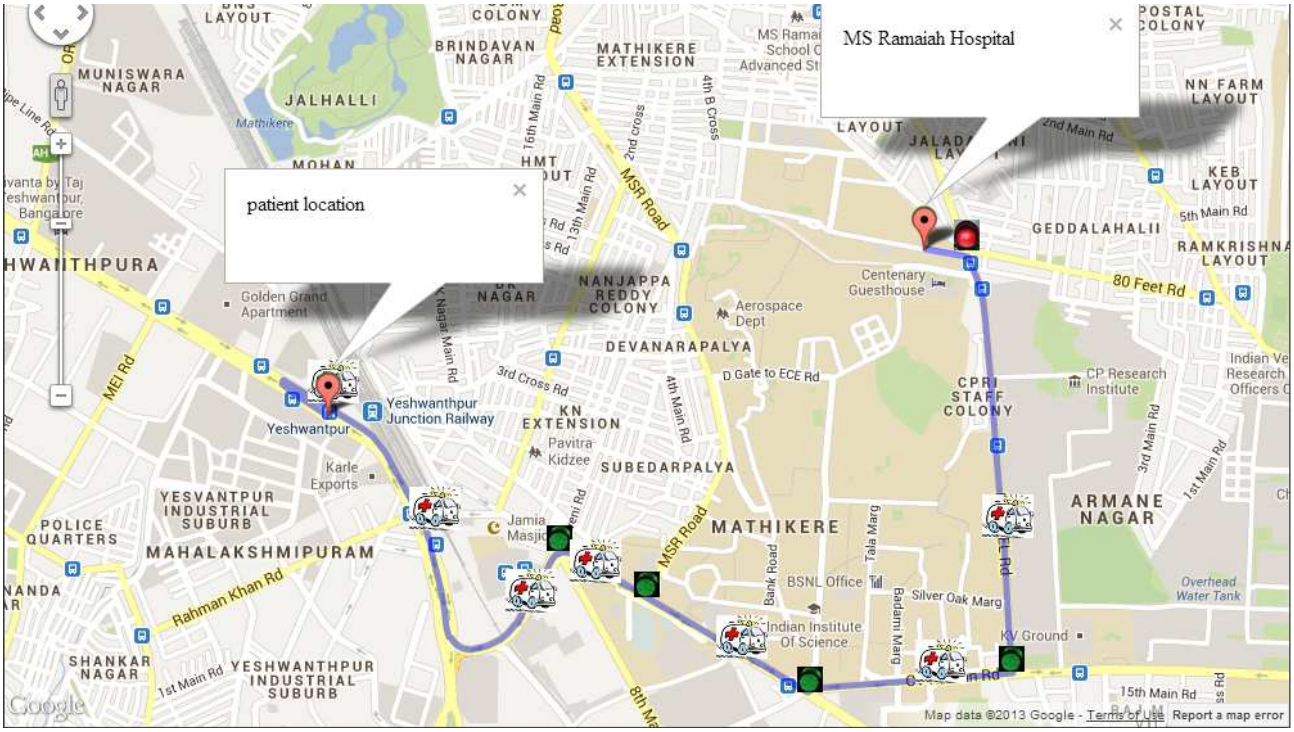

Fig. 5 Emergency Traffic Controlling Unit

Since ESR is established on geographic scale it is likely that proposed system will not be burdened by the incoming requests, also measures can be taken to forward request to idle ESR if the nearest ESR is too busy to handle the incoming request.

Conclusion

In this paper we have demonstrated how the central service responder can be used along with real time context data for better service in hospital environment. Different proposals are put forward to learn the health status of patient and forming a agent that exhibit the property of being autonomous and interactive [10], while other agent systems have been applied to a wide variety of applications ranging from commercial to military to educational, none have considered the fact of patient mobility disturbance while travelling thus utilizing the integrated system of application on Smartphone, mobile agent on ambulance, central service responder, hospital service responder and emergency traffic controller we were able to help patient in getting treatment sooner and allow dynamic responses as demanded by the context awareness environment.

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